2700 feet, with a rainfall of about 120 inches and a mean annual temperature of 70° Fahr. This is perhaps the lowest elevation for the more valuable cinchonas at the Government plantations; the same species flourishes at 5000 feet, with an annual rainfall of 136 inches and a mean annual temperature of 60° F. The trees at this elevation do not seed freely, and it may be taken as the highest at which it would be advisable to cultivate the red bark in Jamaica. The range of cultivation for the valuable crown bark (*Cinchona officinalis*) is between 4500 and 6300 feet of elevation. It may here be convenient to refer to the department—that of Public Gardens and Plantations—which was newly organised in 1879. This department has under its control the Botanic Gardens at Castleton and Bath, the Park at Kingston, the Cocoanut Plantation at Kingston Harbour, and the Hope and Cinchona Plantation. The staff is directed by Mr. Daniel Morris, M.A., who had been assistant at the Ceylon Botanic Gardens. To an island dependent as Jamaica is for its prosperity on the produce of its soil, the importance of such a department is undoubted, and we trust that the new director will receive all due encouragement in developing the botanical treasures of the place.

The concluding parts of this most interesting handbook are devoted to the political constitution and parochial boards of the island; to the details of the various departments and colleges; to the statistics of population, crime, &c.; to the laws of quarantine, &c.; together forming a most useful volume of reference. There seems little doubt that if the capabilities of Jamaica were better known, it would attract the attention of settlers. There are surely as great attractions in bark or coffee-growing as in wool-growing, and Jamaica is nearer to us than the Australian colonies, and, with due precautions, as healthy a climate to live in.

OUR WINTER REFUGES—THE SOUTH OF ENGLAND[1]

II.

As regards temperature and rainfall the South of England, from Dover to Portland, presents a unique and well-marked winter climate, quite distinct from that of any other tract of the British Islands. The tract in question embraces the comparatively narrow belt, varying in width from two to ten miles, stretching between these two places and backed on the north by the sheltering range of the South Downs.

The rainfall in the east of England, from the Humber to Ramsgate, varies in the average annual amounts from 22 to 25½ inches; but on reaching Dover it rapidly rises to 30 inches, and from this point westward to Portland the rainfall varies only from 28 to 30 inches, the amounts differing within these narrow limits according to the flatness or boldness of the coast, and the character of the country in the immediate neighbourhood. To the west of Portland, along the coast, the rainfall rises considerably, and after passing Prawle Point, more rapidly to 44 inches at Penzance. Further, on striking inland from the coast towards and up the slopes of the Downs, the annual amounts increase to about 34 or 36 inches, on the high grounds separating the valley of the Thames from the lands sloping south to the channel; and from this ridge northwards it gradually falls to about 25 inches round London. Thus the Downs, as regards the rainfall and the winds, have important bearings on the meteorology of the south of England.

Equally decided are the temperature characteristics which mark off, climatically, these districts of England from each other. We may accept January as fairly representing the temperature peculiarities of the winter months. In this month the mean temperature of the whole of the eastern slope of Great Britain, from Wick to Dover, varies only from about 37°·5 to 38°·5, the temperature of the coasts being a little higher than that of the interior. But on arriving at Dover we encounter a January mean temperature of 40°·0, and from this point westward there is a steady increase, first slow as far as Worthing, where the mean is 40°·4, and then more rapid to Bournemouth, where the mean is 41°·2. On advancing inland upon the Downs, temperature falls much more rapidly than what is due to mere height, and this fall is continued in proceeding northwards towards London, the mean of which is 2°·5 and 1°·5 lower than that of Bournemouth and Brighton respectively. West of Portland the increase of temperature is still more rapid, the mean being 42°·9 at Torquay, 44°·6 at Falmouth, and 46°·2 in the Scilly Isles, the last temperature being the mean of London in the beginning of April.

Hence if the invalid requires a winter climate characterised by the combined qualities of mildness and dryness, such a climate must be sought for on the shores of the Channel from Dover to Portland. In the south-west a much higher temperature may be had, but the climate is there damper, and raw weather is of much more frequent occurrence; and in the eastern counties the climate is as dry, or rather drier, but the temperature of the air is from 2°·0 to 3°·0 colder.

The south coast possesses another climatic advantage of no small importance. The prevailing winds in the south during the winter months are west-south-westerly, and thus the winds which blow over the Isle of Wight pass on in the direction of London. Now we have seen that in passing from the Isle of Wight to London the mean temperature gradually falls 3°·0—the depression being due to the more rapid rate at which the land, as compared with the sea, is cooled down by terrestrial radiation. From this steady and continued lowering of the temperature of the south-westerly winds as they advance inland from the coast, it follows that haze and cloud are formed with greater frequency and of greater denseness as the winds successively advance into the colder districts. Hence the skies of the south coast are clearer and brighter than in the valley of the Thames—a consideration of the highest climatic significance in the cure of many diseases.

The generally light and porous character of the soil and subsoil along the south coast is a strong recommendation in favour of the sanataria of that region; because, as it affords a ready escape for the rain, the roads are quickly dry, and out-door exercise may be safely indulged in shortly after the rain has ceased. The generally bold character of the coast and sloping character of the surface is also advantageous as offering facilities for carrying out an effective system of drainage.

We have referred to the Downs as affording more or less shelter to the south coast from northerly winds, and to the Undercliff as a protection to Ventnor from north-east, north, north-west, and west winds (NATURE, vol. xxv. p. 33). Indeed the chief source of the advantages possessed by one of these watering-places of the south over another is the degree of protection it holds out from the deleterious effects of the easterly and north-easterly winds, and in some degree also to its distance from those parts of the Continent from which the east wind blows. Of the strictly local peculiarities which give one place a decided preference over another is the extent to which the district is planted with well-grown trees, by which the force of the winds, particularly east winds, is broken up and dissipated. In this respect the firs which have been planted in and around Bournemouth strongly recommend this sanatarium to the invalid, since, if fair overhead, he can almost always take outdoor exercise along the walks and promenades which are so completely sheltered by these evergreens. Bournemouth has the additional advantage of being to some extent protected from the full violence

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[1] Continued from p. 34.

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of the south-west winds by the South Downs of Dorsetshire, and also, though in a less degree, from the east winds by the Isle of Wight.

Since the averages here used are all for the twenty-four years ending with 1880 for the temperature, and for the twenty-one years ending with 1880 for the rainfall, the figures for these two chief elements of climate are strictly comparable throughout. The result is that all strong statements sometimes made in favour of local climatologies, such as the rainfall of Ventnor being as small as that of London, entirely disappear. Such differences could easily be found by the results of different terms of years suited to the purpose, being selected for the particular places whose climatologies are compared. All such comparisons, however, are not merely worthless, they are misleading.

It is, however, now indubitably shown that the south coast of England, from Dover to Portland, enjoys the best winter climate anywhere to be found in the British Islands as respects the two important qualities of mildness and dryness combined, and it is highly probable that the climate of the same tract has clearer, brighter skies, and consequently more sunshine, than elsewhere in these islands. In view of the results of Buchan and Mitchell's investigation into the weather and health of London (NATURE, vol. xxiv. pp. 143 and 173) it is evident that it is to the South of England the invalid who suffers from bronchitis, pneumonia, or other throat diseases, must look for the climate best suited in the treatment of his case, and that it is to the same climate, owing to its clearer air, brighter skies, and more frequent sunshine, that those suffering from nervous and mental diseases should look as more likely to give them the relief they are in search of.

TORNADOES, WHIRLWINDS, WATERSPOUTS, AND HAILSTORMS

I.

WHILE identical with and resembling cyclones in not a few of their leading characteristics, tornadoes and whirlwinds are yet in several all-important respects widely and radically different. The largest tornadoes are of so small dimensions when compared with the smallest cyclones as to point to a difference so decided that admits of no shading of the one class of phenomena into the other. Again, cyclones occur at all hours of the day, whereas whirlwinds and tornadoes are all but restricted to the warmer hours of the day, and perhaps altogether to the time of the day when the sun is above the horizon. Further, and intimately connected with the above, cyclones take place under conditions which imply unequal densities at the same heights of the atmosphere, whether these be due to inequalities in the geographical distribution of temperature or humidity; but whirlwinds occur where the air is unusually warm or moist for the time, and where, consequently, temperature and humidity diminish with height at an abnormally rapid rate. To put it otherwise, cyclones are phenomena consequent on a disturbance of the equilibrium of the atmosphere considered horizontally, but tornadoes, on the other hand, have their origin in a vertical disturbance of atmospheric equilibrium.

Hence whirlwinds are of occasional occurrence nearly everywhere, penetrating into regions where cyclones are altogether unknown; and even tornadoes, which are the most violent and destructive manifestations of the whirlwind, are phenomena either of rare or of frequent occurrence in nearly all climates.

Among the most remarkable of the tornado-swept tracts of the globe are certain portions of the United States of America; and to the examination of these the Meteorological Service of the States has given special attention by a systematic, careful, and minute observation of their attendant phenomena and their destructive effects. The results of these inquiries have been for some years recorded with great, but by no means too great, fulness and elaborateness in the annual meteorological reports of the Chief Signal Officer. Much has been done of late years, as our readers are aware, by observation and discussions of observations, to throw light on these atmospheric meteors; and in this connection we have the greatest pleasure in referring to Prof. Ferrel's recently published "Cyclones, Tornadoes, and Waterspouts," Part II., the portion of which, bearing on tornadoes and whirlwinds, is the most successfully handled part of that very suggestive work, and indeed presents the best theory of whirlwinds yet propounded.

Tornadoes, whirlwinds, and waterspouts are essentially the same, differing from each other only in their dimensions, their intensity, or in the degree in which the moisture is condensed into visible vapour; while the extraordinary downfalls of hail or rain, constituting the hailstorm and rainstorm, are simply the manner and degree of the precipitation. In the waterspout the main features of whirlwinds are best seen, owing to the degree, more or less complete, in which the vapour has been condensed into visible cloud through the whole length of the meteor.

Figs. 1, 2, and 3 represent different forms of the waterspout. In Fig. 1 is seen the black cloud covering the sky, from which a projection is let down from the cloud in the form of an inverted cone as at A, which continues to increase and extend downwards. The surface of the sea at D immediately beneath is soon seen to be stirred, and quickly thrown into a state of violent agitation. At this stage the whirling movement which originated in the clouds has extended downwards to the sea, and is doubtless continuous throughout, though the portion of the whirling column from A downward is not yet present to the eye by the condensation into cloud of its contained moisture. The cone at A continues to lengthen downwards, and ultimately reaches to the earth's surface as shown at B and C, and by the waterspouts of Figs. 2 and 3. As the whirling movements of the aërial column of the waterspout become more intensely developed, the increasing rapidity of the gyrations brings about increased rarefaction of the air within, with the inevitable result of increased condensation into cloud downward. The protrusion from the clouds and extension toward the surface of the sea of the waterspout is thus not due to the descent of vapour from the clouds, but to the visible condensation of the vapour of the spirally ascending air-currents arising from an increasing rarefaction due to the accelerated rate of the gyrations, the condensation being similar to that of the cloud seen in exhausting an air-pump.

The onward progressive motion of tornadoes and whirlwinds varies greatly, and is probably in all cases that of the general movement of that portion of the earth's atmosphere in which they are embedded and form a part. Tornadoes sometimes rage with destructive violence on heights and hill tops, while intervening valleys remain untouched, thus showing that they occasionally occur at comparatively small elevations, but do not reach down to the surface of the earth. It also sometimes happens that the tornado in its onward course rises for a brief interval above the surface and again descends. As soon as the rapidity of the gyrations of the column become diminished, the rarefaction of the air of the column and the condensation of the vapour are correspondingly lessened, and thereafter the waterspout gradually breaks up and disappears.

Under each of the waterspouts in Figs. 1, 2, and 3 the surface of the sea is seen to be more or less heaped up as well as in violent commotion, indicating that atmospheric pressure immediately under the gyrating column is less than it is all round. On land, when a tornado passes directly over a closed building, many instances have occurred when the whole building, walls and roof, has

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